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EVALUATION OF EXTRUDED DEBRIS AMOUNT DURING INSTRUMENTATION USING RECIPROCATION VS. FULL ROTATION TECHNIQUES: IN VITRO STUDY

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Abstract

Apical extrusion of infected debris into the periradicular tissues during endodontic instrumentation may lead to postoperative pain and flare-up. Debris usually contain dentine chips, necrotic pulp tissue, microorganisms and irrigant. The existing studies are inconclusive about which engine-driven system pushes less debris in the apical direction. The aim of the present study was to evaluate the amount of apically extruded debris associated with full rotation single-file nickel–titanium instrumentation systems compared to another system used in reciprocation motion. Methodology: After approval of BAU institutional review board, twenty extracted human mandibular premolar teeth were randomly assigned to two groups (n=10 per group), the root canals were instrumented according to the manufacturers' instructions using the reciprocating single-file system Reciproc Blue (VDW), and the single-file rotary system OneCurve (MicroMega). The apically extruded debris were collected and dried in pre-weighed Eppendorf tubes. The amount of debris was assessed with a micro balance and statistically analyzed using Mann-Whitney U Test. The results showed that both systems produced debris with no statistically significant difference between them. Conclusions: Under the condition of this study, both systems caused apical debris extrusion. Reciprocal instrumentation was associated with more debris extrusion compared to rotary instrumentation, however without statistically significant difference.

Keywords

Apical extruded debris, reciprocation, full rotation, Nickle Titanium instruments, single file system.

1. INTRODUCTION

The endodontic treatment aims at biomechanically preparing the root canal (cleaning, shaping and disinfection) to eliminate viable bacteria and toxins and achieve three-dimensional obturation to completely seal the canal without causing a discomfort to the patient (Uzunoglu and Turker 2016). This kind of treatment also sets adequate conditions for the periradicular tissues to recover and heal. (Logani and Shah, 2009)

The definition of the inter-appointment flare-up refers to swelling and/or pain following an endodontic treatment appointment, requiring an unscheduled visit and active treatment. (Jayakodi et al. 2012). Accordingly, the human body's defensive system gets more activated to adapt to and fight the infection caused by the flare-up. As a consequence, clinical symptoms like undesirable tooth pain during biting or chewing start increasing (Uzunoglu and Turker 2016). The materials extruded during or after the endodontically treated teeth could be irrigants materials, remnants of necrotic pulp tissue, intracanal filling materials, and bacteria. (Logani and Shah2009). The occurrence of the said clinical symptoms could mainly decide by the amount of extruded debris, type of bacteria extruded or presented the initial pathology, and the human body's response.(Labbaf et al, 2015).

Reducing the amount of extruded debris during endodontic treatment is proposed as a method of preventing inter-appointment and post-treatment pain and flare-up. Some research papers claim that the flare-up rate after endodontic treatment varies from 1.4% to 16% and up to 50% (Siqueira et al, 2002; Logani and Shah, 2009; Uzunoglu and Turker, 2016).

The root canal treatment using all instrumentation techniques causes debris extrusion from the apex even when the techniques are shorter than the apical terminus. Some researchers showed that the usage of the crown-down technique during instrumentation causes less amount of extrusion debris through the apical foramen (Vivekanandhan et al, 2016).

A recent study reported that instrumentation using hand instruments (step-back techniques) causes average extrusion debris amount equivalent to 2.58 mg. On the other side, using rotational mechanical instruments (crown-down techniques) is less than 0.5 mg. As a result; the step-back technique causes more debris than other techniques (Gambarini et al. 2017).

Recently, using a single- file system, which reduces the number of instruments used during root canal preparations may reduce the time during the root canal instrumentation, effected on more extrusion of debris or/and accumulation of debris on the apical area. (De-Deus et al, 2015)

Additionally, reciprocation motion, as the mechanism of action in most of the single-instrument systems, mimics the kinematics of balanced force technique, which is proven to be a pressure less movement pushing less material in apical direction (Cleghorn et al, 2006). However, since the reciprocation is presumed to be a forceful movement, it may pump debris and irrigant through the apex like a mechanical piston. (Myrna et al, 2018).

2. AIM OF THE STUDY

To evaluate and compare the amount of apically extruded debris in extracted teeth using reciprocating single-file system Reciproc Blue (VDW), and the single-file rotary system OneCurve (MicroMega).

3. MATERIALS AND METHODS

This study was conducted after approval of BAU institutional review board with Number 2019H-0071-D-R-0356

3.1. Samples Preparation

Twenty extracted human lower premolars (N=20) were selected and randomly divided into two equal groups (N=10) according to the instrumentation's technique using One Curve (micro-mega) vs. Reciproc®Blue (vdw). Preoperatively, periapical radiograph were taken; buccolingually and mesiodistally to define single canal. Inclusion criteria included minimal curvature <5° according to Schneider (1971).

A single operator carried on the process of preparing root canal. For disinfection purposes, specimens were immersed in 0.5% sodium hypochlorite solution for 48 hours ahead the experiment. Before instrumentation, a periodontal scaler used to remove soft tissue, pulp remnants, and calculus from the root surface (Labbaf et al, 2017).

A Periapical radiograph was taken and teeth with calcification, open apices, internal or external root resorption, severe curvature and cracked root, were excluded.

The crowns of all teeth were cut above the CEJ level to ensure a flat coronal reference point with diamond disc double sided 0.2x22mm using low speed handpiece and to standardize the root length of at 16 mm.The working length measured using K-File (010/02), once the tip exits the apical foramen the file is retrieved one mm. Teeth were excluded if the #15 file tip extended beyond the apical foramen.

The study outcome measured the mean and standard deviation of apical extrusion of debris measured in milligrams (Ohaus Pioneer PA4102).

3.2. Collection of Extruded Debris

Collections of apically extruded debris were conducted according to the technique developed by (Fairbourn et al, 1987) and modified by (Myers and Montgomery, 1991)

Eppendorf tubes were adjusted with a heated instrument to create a hole through the center. The prepared teeth were adapted under pressure into Eppendorf tubes. A hole was created on the cap of an Eppendorf tube, and teeth were inserted up to the cement-enamel junction. (Dagna et al, 2017)

A 25-G was placed alongside the cap as a drainage cannula to equalize air pressure inside and outside the Eppendorf tubes .

Then, each cap with the tooth and the needle were attached to its Eppendorf tube, and the Eppendorf tubes were then fitted into vials. (Figure 1)

Before canal instrumentation, the Eppendorf tubes were weighed 3 to 5 precision using a microbalance. To avoid variation and eliminate bias, the tubes were covered with Teflon and the cleaning, shaping and irrigation of all samples were completed by single operator. Each file was replaced after one time of usage.

Upon completion of the canal preparation, the Eppendorf tubes were removed from the vials. The debris adherent to the external surface were collected by washing the root with 1 ml distilled water in the tube. The tubes were stored in an incubator at 70 °C for 5 days to evaporate the distilled water before weighing the dry debris .

Dry weight of extruded debris was calculated by subtracting the weight of empty tube from that of the tube containing debris. The study outcome measured the mean and standard deviation of apical extrusion of debris measured in milligram (Ohaus Pioneer PA4102).

3.3. Statistical analysis

Data analysis was carried out by SPSS 23.0 Software. Descriptive statistics for extruded debris were calculated by using mean and standard deviation. The Non Parametric test like Mann-Whitney U test was applied to determine the significant differences among the group. $p< 0.5$ was taken as statistically significant.

Fig.1: Shows the apparatus prepared for the collection of apically extruded debris as described by Myers and Montogomery (1991).
Photograph taken at Beirut Arab University April 2019

4. RESULTS

The mean extrusion values (mg), standard deviation (SD) for each group, median values and the range of extrusion (minimum and maximum values) of the two experimental groups are presented in Table 1.

The results showed that both systems produced debris and the mean apically extruded weight of debris in the One Curve group was 0.017±0.008 mg , which is more than extruded debris with the Reciproc Blue (0.015± 0.007 mg) however, when compared no statistically significant differences was found between them.

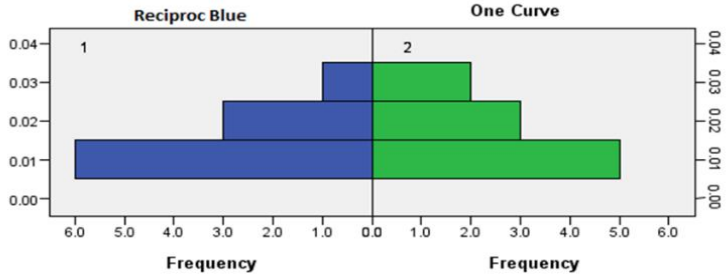
Table1: Mean, standard deviation, median and range of extrusion values in the two group Statistics

		Reciproc Blue	One Curve
N	Valid	10	10
Mean		.0150	.0170
Median		.0100	.0150
Mode		.01	.01
Std. Deviation		.00707	.00823
Range		.02	.02
Minimum		.01	.01
Maximum		.03	.03

Due to the non-normality of our data, Mann-Whitney U Test was used. It is a non-parametric test that is used to compare two sample means that come from the same population, and used to test whether two sample means are equal or not. As shown in table 2, (p-value=0.631>0.05), there is no significant difference between the means of the distribution of Reciproc Blue and One Curve groups.

Table 2: Mann-Whitney U test showed no significant difference (U = 56, p = 0.631) between the two systems.

Independent-Samples Mann-Whitney U Test



Total N	20
Mann-Whitney U	56.500
Wilcoxon W	111.500
Test Statistic	56.500
Standard Error	11.871
Standardized Test Statistic	.548
Asymptotic Sig. (2-sided test)	.584
Exact Sig. (2-sided test)	.631

5. DISCUSSION

A major objective of root canal therapy is to obtain a clean root canal system. Debris such as dentine chips, necrotic pulp tissue, microorganisms and irrigants may be extruded into the periradicular tissue during instrumentation which leads to postoperative pain and flare-up. Apical extrusion of infected debris to the periradicular tissues is possibly one of the principle causes of this post-operative pain. (Seltzer et al, 1985).

Many factors affect the amount of extruded debris such as the instrumentation technique, instrument type and size, preparation endpoint and irrigation solution (Azar et al, 2005; Tinaz et al, 2005)

Results from the existing studies were inconclusive about which engine-driven system pushes less debris in the apical direction. While some indicated that rotational movement extrudes lesser amount of debris, others demonstrated higher amount of debris extrusion in comparison to reciprocation motion (Tinaz et al, 2005). (Surakanti et al, 2014)

In previous studies (Hwang et al, 2014; Simpsyet al, 2016), reciprocating single-file techniques (Reciproc) were found to produce more significant inflammatory response and pain when compared to a rotary nickel-titanium crown down instrumentation technique.

Azar et al, 2005, considered that extrusion of debris is more likely to occur when reciprocation motion is used, because the flutes are designed to remove debris only in one direction. Therefore, while the cutting angle removes debris coronally, the releasing angle tends to push debris apically.

Reciproc blue (VDW, Munich, Germany) technique uses a quite rigid, single-file of increased taper (usually 07/08 taper, size 25) with 16 mm working part. Since instruments are used without any preliminar coronal enlargement, progression to the apex often results in a greater engagement of flutes and, consequently, more debris are entrapped, requiring more torque or applied pressure to reach the working length 1 mm shorter than working length (Somma et al, 2008)(Burklein and Schafer , 2012).

A study conducted by (De-Deus et al, 2010) found that when the ProTaper Universal file F2 was used in a reciprocating motion, no significant difference was found between the full sequence of ProTaper Universal and the single ProTaper file F2, both causing similar amounts of apical extrusion of debris. The authors also stressed that their study was unable to confirm the influence of the type of instrument movement on the amount of debris extruded apically.

Burklein and Schafer (2012) reported that the reciprocating systems resulted into more debris compared with the rotational systems. This come in accordance with results of a recent report that rotary instrumentation was associated with a reduced amount of debris extrusion .(Tanalp and, Gungor, 2014).

The main objective of the present investigation was to determine the apical extrusion of dentine debris as a result of canal shaping by different rotary systems. Several laboratory experimental set-ups have been designed in order to evaluate the amount of debris extrusion into periapical tissues during root canal shaping. (Tanalp and Gungor, 2014). The system adopted in this study has been widely used and is the one described by Myers and Montgomery, (1991).

Straight single-rooted teeth were used in this study to eliminate any possible variables and to prevent loss of working length, which might damage the apical constriction and may allow more extrusion.

The main disadvantage of this model is that the pulpal status and condition of the periapical tissues as well as the pressure at the periapex cannot be mimicked. Even if some sort of simulation is provided, the structure and condition of the tissues as well as pulpal status cannot be standardized (Salzgeber and Brillant, 1977)

All techniques and methods that have been utilized in the literature are based on a quantitative measurement of debris. This approach may not be rational as they lack the accomplishment of a qualitative analysis on the content of extruded material. A low amount of extruded material may have a higher potential of initiating periapical response due to a bacterial content of high virulence and antigenic characteristics compared to a higher quantity, lacking the specific threshold value of irritation. (Somma et al, 2008)

One of this study limitations is the small number of samples investigated. Higher number of sample is recommended for future study

In the present study, apical extrusion of debris was noticed in all groups. Distilled water use was preferred as an irrigant in order to avoid the possible effect of crystallization of sodium hypochlorite on the results (Huang et al, 2007). However, there is no sufficient literature data whether type of irrigant can affect the amount of debris extrusion. (Burklein and Schafer, 2012).

6. CONCLUSION

Under the condition of this study, both systems caused apical debris extrusion. Reciprocal instrumentation was associated with more debris extrusion compared to rotary instrumentation with no statistically significant differences was found between them. Extrusion of the irrigant is not influenced by the type of instrument or techniques used in canal preparation. It may be necessary to find instruments and techniques that would minimize the extrusion of such elements and help to reduce the incidence of flare-ups in endodontics.

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